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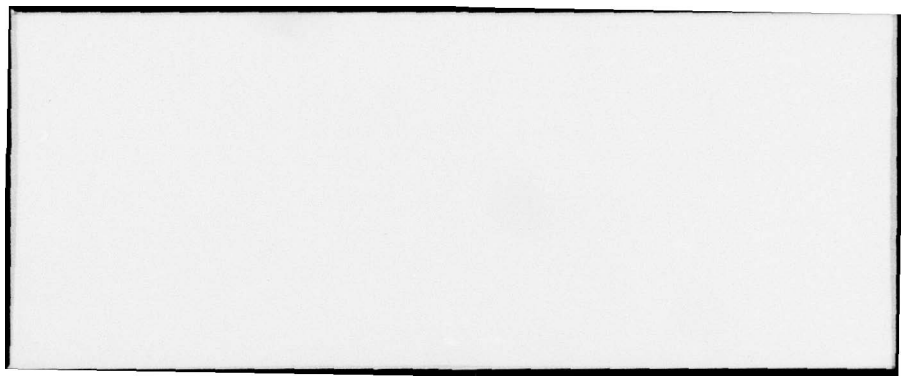

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DATA SUMMARIZATION IN A WEATHER MODIFICATION EXPERIMENT: II. CONCOMITANT VARIABLES,

by

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PREFACE

This report deals with the summarization of measured concomitant variables available from Phase 1 of the Santa Barbara Convective Band Seeding Test Program conducted for the Navy by North American Weather Consultants in the 1967-68 to 1970-71 seasons. We are indebted to NAWC for provision of data tapes for our analyses.

This report is preliminary to analyses under way in reexamination of the effects of cloud seeding on the cited program and is part of a larger program to develop improved methodology on the design and analysis of weather modification experimentation. It [illegible]ned that data reported here will be used in association with [illegible]ummarizations of precipitation data given in separate reports. A listing of other technical reports issued under this contract is appended to this report.

Ralph A. Bradley
Principal Investigator

DATA SUMMARIZATION IN A WEATHER MODIFICATION EXPERIMENT: II. CONCOMITANT VARIABLES[1]

by

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1. Introduction.

This paper presents tabulated values of concomitant meteorological variables for Phase I of the Santa Barbara Convective Band Seeding Test Program conducted for the Navy by North American Weather Consultants in the 1967-68 to 1970-71 seasons. They were obtained from data supplied through the courtesy of NAWC.

The importance of such variables was stressed by Estoque and Fernandez-Partagas [2] in a study of precipitation dependence on synoptic-scale conditions and cloud seeding: "We found that the variation of synoptic-scale conditions is, by far, much more important than multiple cloud seeding in determining precipitation. This finding indicates that cloud seeding experiments in Florida which do not take into account the effect of the varying synoptic conditions, can lead to misleading conclusions."

The synoptic-scale parameters they used are the prevailing flow, stability, humidity and vertical wind shear. Only the last of these appeared to have little value in their study.

In the Santa Barbara project, the concomitant variables deemed important are stability, 700-mb wind speed and direction, and 500-mb temperature (the latter being regarded as an approximation to cloud-top temperature). See Thompson et al [5] for further details.

[1]Research supported by the Office of Naval Research under Contract No. N00014-76-C-0394.

We have examined radiosonde data from this project and obtained values of the following variables: wind speed and direction, mixing ratio (a measure of humidity), Showalter Index (a measure of stability), horizontal gradient of stability, and horizontal transport of instability. These are average values for atmospheric layers. A set of such values is available for each of 106 bands in a 107-band total from Phase I of the project. All values are presented in Table 1 along with data on the variables mentioned in the previous paragraph.

The next section has a detailed description of Table 1 and the variables represented therein. In the final section, there is a discussion of some statistics calculated from data in Table 1.

2. Description of Variables in Table 1.

(Numbers in parentheses refer to rows in the table.)

(1) Date on which band arrived at seeding site.

(2) Time when band passage began at seeding site, Pacific Standard Time (PST).

(3) Time band passage ended at site, (PST).

(4) Treatment of band. NS indicates nonseeded; S, seeded. If band was seeded, number of fuses ignited is shown.

(5) Number of radiosonde observations selected to represent atmospheric conditions associated with band.

(6) Station that released radiosonde:

SBA - NAWC office at Santa Barbara Airport

VBG - Vandenberg AFB

392 - Point Arguello/Vandenberg

NSI - San Nicolas Island

NTD - Point Mugu.

(7) Time of radiosonde release, (PST).

(8) Mixing Ratio, (grams of water per 1000 grams of dry air). This is a measure of the water-vapor content in a vertical column from 990-millibars (mb) pressure to 600 mb, or from the surface to 14,000 ft., approximately. Radiosonde values of temperature and dew point were used to find mixing ratios with the aid of a thermodynamic diagram (Skew T-Log P Diagram). Values were obtained at 100-mb intervals approximately, and averaged to give final value.

(9) 700-mb Speed (knots) of the 700-mb (10,000 ft.) horizontal wind, from Thompson et al [5].

(10) Direction (degrees east of north) of the 700-mb wind.

(11) Mean Speed (knots) of horizontal winds in the layer from 1000 ft. to 14,000 ft. elevation. This is the magnitude of the average vector (or resultant) wind, calculated from available observations at 1000-ft. intervals up to 10,000 ft. and at 2000-ft. intervals thereafter. If data were missing from one or two levels, values in table are enclosed in parentheses, as are values of other variables (rows 12, 16, 17, and 18) that depend on these observations.

(12) Direction (degrees east of north) of average vector wind.

(13) 500-mb Temperature (degrees Celsius), from Thompson et al [5]. This is an approximate measure of cloud-top temperature, at about 19,000 ft.

(14) Stability Class, from Elliott and Thompson [1].

UL - unstable, low convective instability base

UH - unstable, high convective instability base

ST - stable.

A convective instability base is the lowest level in the atmosphere where the rate of decrease of temperature with height (as determined from a radiosonde observation) exceeds the rate of temperature decrease with height that would occur in a mass of saturated air at the same temperature

as that of surrounding air, if it were lifted. Classes are listed in order of increasing atmospheric stability.

(15) Showalter Index: (degrees Celsius): a measure of stability, determined from radiosonde observations with the aid of a thermodynamic diagram. The temperature that a small mass of moist air would have if it were lifted from the 850-mb level (approximately 5000 ft.) to 500 mb, is subtracted from the observed temperature at 500 mb, and this difference is the Index value. Large positive (negative) values of the Index indicate atmospheric stability (instability), according to theory and to some practical experience in the past. See Showalter [4] for initial presentation of Index.

(16) Stability Wind (knots) refers to the magnitude of the vector V_s:

$$V_s = (V_9 - V_6) - (V_6 - V_3)$$

where V_3, V_6, and V_9 are the horizontal wind vectors at 3000, 6000, and 9000 ft., respectively, and $(V_6 - V_3)$ and $(V_9 - V_6)$ are thermal-wind vectors for the 3000-6000-ft. layer and 9000-6000-ft. layer respectively. According to fairly reasonable physical assumptions, the so-called thermal wind blows along a line parallel to mean isotherms of an atmospheric layer with higher temperatures to the right as one faces downstream. The so-called stability wind is the difference between two thermal winds and blows along a line parallel to lines of constant atmospheric stability in the 3000-9000-ft. layer, with higher stabilities to the right as one faces downstream. In this context, higher (lower) stability prevails in a layer where the decrease of temperature with height is relatively small (large). In principle the magnitude of V_s varies directly with horizontal gradient of stability. See Saucier [3] for discussion of this subject.

Note that effects of latent heat of condensation are not considered here, but are considered in determination of the Stability Class and Showalter Index (rows 14 and 15).

Values of Stability Wind speed (and direction) were calculated from radiosonde observations.

(17) Direction (degrees east of north) of Stability Wind. For example, 241 degrees (see Radiosonde 2, SBA). This value indicates the most (least) stable air is to be found approximately southeast (northwest) of Santa Barbara.

(18) Instability Transport (knots^2) refers to the magnitude of the vector cross-product, $V_6 \times V_s$, where V_6 and V_s are as defined above. This is a measure of the time rate at which less stable air is being transported by horizontal winds to the vicinity of the radiosonde station and seeding site. If this quantity is negative the arrival of more stable air is suggested.

To a first approximation, the 6000-ft. wind V_6 was used to represent the transporting wind in the 3000-6000-ft. layer when calculating the values displayed in the table.

3. Discussion.

Means and standard deviations of concomitant variables were calculated from data in Table 1 and are shown in Table 2. Values were obtained separately for nonseeded and seeded bands to study differences between the two categories.

In a preliminary way, we have introduced, as another concomitant variable in Table 2, the time of day when each band arrived at the seeding site. The reason for doing so is that precipitation tends to be more abundant near noon than during the night because of greater instability that is produced by solar heating of air in the lowest layers. Accord-

ingly, the time when band passage began (Row 2, Table 1) was subtracted from 12 (representing noon). The absolute magnitude of this difference, expressed to the nearest tenth of an hour, is a variable whose summary statistics are shown on the row labelled 'Time Difference' in Table 2.

No data for 'Stability Class' are given in this table because the classes UL, UH, and ST are merely descriptive. However one would expect some relationship between these classes and the Showalter Index (which is represented in Table 2) because both variables are concerned with stability. In Table 1, UL, UH, and ST appear 73, 33, and 10 times, respectively. The average values of the Showalter Index for the three groups are 3.0, 3.3, and 7.5, respectively, indicating a positive relationship between the two variables.

Examination of Table 2 reveals no major differences between results for nonseeded and seeded bands. For each and every variable the difference of means is considerably smaller than either of the standard deviations.

Although these differences are small, they do exhibit some consistency:

The time difference between noon and the beginning of band passage at the seeding site (Row 2) has a smaller average for seeded bands (5.7) than for nonseeded bands (6.6).

The water-vapor content of the air (Row 8) has a slightly larger average for seeded bands (5.1 versus 5.0).

The mean speed of the winds (1000 to 14,000 ft.), bringing moist air inland (Row 11), is greater for seeded bands (28 versus 26).

The Showalter Index (Row 15) indicates less stability for seeded bands (3 versus 4).

Instability transport into the region of study (Row 18) has a larger average value for seeded bands (116 versus 72).

Taken separately the effect of each of these differences may be insignificant, but in combination they suggest that the total precipitation that might have been realized from seeded bands, had they not been seeded, would have been larger than the total amount that fell from nonseeded bands. Further analysis of relationships between concomitant variables and observed precipitation may be informative on this issue.

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[1] Elliott, R. D., and J. R. Thompson (1971): Santa Barbara Convective Seeding Test Program 1970-71 season and 1967-71 summary, NWC Technical Publication 5308.

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TABLE 1. Chronology of Bands and Associated Meteorological Variables in Phase I of Santa Barbara Project.

Row	Variable	Band Number 1	2	3	4	5	6	7	8	9	10
1	Date	1/27/68	1/27/68	1/27/68	1/27/68	1/30/68	1/31/68	2/12/68	2/16/68	2/16/68	2/16/68
2	Begin	0930	1030	1145	1315	2000	0155	1900	1600	1700	1910
3	End(PST)	0945	1130	1210	1430	2230	0230	2000	1625	1820	1930
4	Treatment	NS	NS	NS	S2	S4	NS	S4	S2	NS	NS
5	Radiosonde	2	3	4	6	7	8	10	11	12	14
6	Station	SBA	SBA	SBA	SBA	SBA	NSI	SBA	VBG	SBA	SBA
7	Time(PST)	0955	1110	1230	1546	2115	0400	1920	1515	1740	1947
8	Mixing Ratio	5.1	4.6	4.2	3.2	4.1	4.5	4.7	5.8	5.3	5.8
9	700-mb Speed	33	33	35	35	35	35	15	24	30	25
10	Direction	230	230	230	230	240	260	170	230	230	240
11	Mean Speed	19	22	24	27	24	30	14	23	15	20
12	Direction	240	230	224	244	234	264	178	201	199	220
13	500-mb Temp.	-26.2	-26.8	-27.0	-28.2	-20.7	-20.0	-23.0	-18.3	-18.1	-18.0
14	Stability Class	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL
15	Showalter Index	4	-1	1	3	7	5	4	3	10	5
16	Stability Wind	38	43	44	50	41	50	26	41	26	40
17	Direction	241	229	223	249	227	267	169	191	183	213
18	Instability Transport	138	8	-106	169	40	168	58	151	17	28

TABLE 1. (CONT'D)

Band Number

Row	11	12	13	14	15	16	17	18	19	20
1	2/16/68	2/17/68	2/17/68	2/17/68	3/7/68	3/8/68	3/13/68	3/16/68	4/1/68	4/1/68
2	2300	0430	0715	1045	2120	0230	0230	1330	1200	1500
3	0030	0600	0800	1200	2315	0300	0600	1430	1400	1530
4	NS	NS	NS	S5	S6	S3	S9	NS	S6	S2
5	15	16	17	18	20	23	26	27	29	30
6	SBA	VBG	SBA	SBA	VBG	SBA	VBG	SBA	SBA	VBG
7	0015	0315	0800	1100	1515	0300	0315	1424	1357	1515
8	6.6	6.2	6.4	7.0	5.0	5.3	4.8	4.6	4.6	3.2
9	25	26	25	25	31	32	28	39	30	29
10	260	270	270	280	240	240	220	250	245	260
11	20	20	14	5	31	24	25	27	28	26
12	244	232	260	262	220	240	234	240	211	263
13	-15.0	-14.3	-16.6	-16.2	-22.3	-24.5	-21.0	-20.8	-23.2	-27.1
14	UL	UL	UL	UL	UL	UL	ST	UL	UL	UL
15	3	3	-2	-1	3	-2	8	4	2	4
16	39	43	24	9	63	41	40	42	50	50
17	240	219	252	254	219	235	240	240	207	263
18	-5	304	-13	-5	-3	135	-204	-8	-193	183

TABLE 1. (CONT'D)

Band Number

Row	21	22	23	24	25	26	27	28	29	30
1	4/1/68	4/1/68	11/14/68	11/14/68	11/15/68	11/15/68	12/10/68	12/10/68	12/14/68	12/15/68
2	1900	2215	2150	2350	0100	0350	1605	1930	0500	2145
3	1945	2315	2325	0400?	0130	0430	1840	2035	0700	2355
4	S1	NS	NS	NS	S3	NS	S2	S4	NS	S10
5	31	32	33	38	39	41	46	50	56	63
6	SBA	SBA	VBG	VBG	SBA	SBA	VBG	SBA	SBA	SBA
7	1945	2100	1515	2345	0045	0400	1549	2141	0642	2341
8	3.7	3.9	3.3	4.4	5.3	4.5	7.0	5.8	4.1	4.8
9	30	32	42	57	35	44	45	36	54	24
10	270	270	285	275	270	275	260	240	220	225
11	26	22	19	44	(23)	21	24	27	24	19
12	266	268	299	254	(236)	265	244	239	227	237
13	-26.2	-26.2	-14.3	-15.8	-19.8	-19.8	-15.5	-18.0	-15.0	-20.3
14	UL	UL	ST	ST	ST	UH	UH	UH	ST	UH
15	2	1	17	8	6	2	2	-1	7	4
16	50	42	32	85	(54)	21	48	49	46	29
17	267	270	292	250	(251)	250	245	228	200	229
18	84	-66	84	526	(-251)	57	164	744	190	17

Note. Values in parentheses here and hereafter are based on wind data with observations missing from one or two levels.

TABLE 1. (CONT'D)

Band Number

Row	31	32	33	34	35	36	37	38	39	40
1	12/24/68	12/24/68	1/13/69	1/13/69	1/13/69	1/13/69	1/18/69	1/19/69	1/19/69	1/19/69
2	1745	1915	1125	1645	2030	2345	1935	0440	0935	1430
3	1820	1950	1245	1945	2215	0130	2110	0640	1230	1600
4	NS	NS	S4	NS	S6	NS	NS	S10	S11	S5
5	65	66	68	70	71	72	75	77	78	79
6	VBG	VBG	VBG	VBG	VBG	VBG	VBG	VBG	VBG	SBA
7	1535	2115	0918	1515	2115	0011	1515	0315	0915	1510
8	4.7	4.4	6.4	6.6	5.7	6.0	5.6	6.3	4.8	7.2
9	46	39	35	23	20	12	41	39	48	45
10	240	240	210	215	275	260	230	240	215	222
11	32	28	33	23	12	11	34	32	42	40
12	230	234	188	199	226	226	212	226	203	220
13	-18.1	-16.8	-15.0	-14.7	-16.8	-18.5	-17.0	-16.9	-16.7	-17.5
14	UH	UL	UH	UH	UL	UL	UL	UL	UL	UL
15	5	5	5	5	3	1	5	2	9	-1
16	62	56	71	49	25	25	71	66	84	84
17	230	231	187	199	239	229	209	226	201	219
18	372	10	271	198	70	73	343	179	35	75

TABLE 1. (CONT'D)

Band Number

Row	41	42	43	44	45	46	47	48	49	50
1	1/19/69	1/19/69	1/20/69	1/20/69	1/21/69	1/24/69	1/24/69	1/24/69	1/24/69	2/12/69
2	1630	1730	2030	2330	0250	0515	1040	1210	1430	0035
3	1710	1930	2140	0150	0430	0515	1140	1350	1610	0200
4	NS	NS	NS	S9	S5	S3	NS	S7	NS	S5
5	80	81	84	85	86	91	95	96	97	99
6	VBG	VBG	VBG	VBG	SBA	VBG	SBA	SBA	VBG	392
7	1515	2115	1800	2214	0312	0315	1136	1344	1515	2115
8	6.9	6.9	5.1	5.9	6.4	6.3	5.9	6.5	7.3	4.2
9	45	33	52	62	54	37	37	37	35	13
10	225	240	200	210	215	245	240	235	235	203
11	41	25	37	53	46	30	22	22	35	14
12	221	230	195	203	211	241	233	231	236	177
13	-17.8	-19.0	-16.7	-14.5	-20.2	-20.1	-18.0	-18.1	-15.6	-20.0
14	UL	UL	UL	UL	UL	UH	UH	UH	UL	UH
15	-1	0	3	8	2	-2	1	-1	3	8
16	84	46	76	110	88	56	43	45	73	34
17	221	231	192	202	211	241	223	220	230	171
18	142	-129	150	-103	358	430	266	661	286	76

TABLE 1. (CONT'D)

Band Number

Row	51	52	53	54	55	56	57	58	59	60
1	2/15/69	2/15/69	2/17/69	2/21/69	2/23/69	2/23/69	2/24/69	2/24/69	2/24/69	2/25/69
2	0420	0600	2215	1715	0415	0600	1330	1525	1630	0015
3	0520	0920	0100	2015	0545	0950	1500	1600	1815	0130
4	NS	S13	NS	NS	NS	S13	NS	S2	NS	S5
5	104	105	108	110	112	113	118	119	121	122
6	SBA	SBA	392	392	VEG	SBA	SBA	VEG	392	SBA
7	0445	0750	2115	2115	0315	0835	1438	1515	2115	0135
8	3.8	5.0	4.2	2.7	4.0	4.4	5.4	5.3	4.8	4.9
9	39	43	15	37	44	44	45	55	51	54
10	235	220	235	235	240	220	195	215	220	230
11	21	27	11	24	34	32	35	(37)	30	33
12	210	192	209	239	218	207	202	(221)	223	229
13	-17.7	-20.3	-24.7	-32.0	-24.5	-23.8	-19.1	-14.0	-21.3	-19.9
14	ST	UH	UH	UL	UH	UH	UL	UH	UH	ST
15	16	5	6	2	5	4	4	4	5	6
16	46	50	20	46	72	60	68	73	51	58
17	194	183	215	251	215	198	200	223	226	230
18	110	72	-13	312	-367	267	-329	-117	-532	373

TABLE 1. (CONT'D)

Band Number

Row	61	62	63	64	65	66	67	68	69	70
1	3/21/69	4/5/69	4/5/69	11/5/69	11/6/69	1/9/70	1/9/70	1/9/70	1/9/70	1/11/70
2	1105	1045	1335	2215	1030	0700	0845	1120	1635	1900
3	1210	1320	1410	2345	1245	0755	0910	1255	1735	1930
4	NS	S12	NS	NS	S6	NS	S2	S7	NS	NS
5	127	133	136	138	143	144	146	147	150	151
6	VBG	SBA	SBA	VBG	SBA	VBG	SBA	SBA	SBA	VBG
7	0915	0915	1405	1515	1110	0315	0907	1200	1710	1515
8	3.1	4.9	5.7	5.6	5.4	5.1	4.5	5.1	5.3	3.8
9	21	44	37	35	24	33	46	49	42	22
10	160	190	195	238	229	216	190	190	200	260
11	17	31	30	20	(18)	31	(27)	34	32	15
12	166	197	185	202	(206)	190	(181)	180	188	233
13	-19.6	-19.9	-23.1	-18.3	-20.5	-20.4	-20.5	-19.0	-19.6	-19.6
14	UH	ST	UH	UL	UL	UH	ST	UL	UL	UL
15	4	1	1	5	3	0	3	2	4	1
16	38	72	54	42	28	63	59	72	65	32
17	165	194	177	204	188	186	163	174	180	235
18	17	213	678	164	-22	103	186	407	383	-39

TABLE 1. (CONT'D)

Band Number

Row	71	72	73	74	75	76	77	78	79	80
1	1/15/70	1/16/70	1/16/70	1/16/70	2/9/70	2/13/70	2/27/70	2/28/70	2/28/70	3/1/70
2	2330	0350	0740	0925	1410	1030	2320	0530	1030	0030
3	0130	0515	0820	0950	1520	1115	0200	0730	1145	0205
4	S8	NS	NS	S3	S4	S4	NS	S6	S5	NS
5	153	154	-	155	158	162	165	166	167	169
6	SBA	VBG	-	SBA	VBG	SBA	SBA	VBG	SBA	VBG
7	0143	0315	-	1002	1515	1120	2320	0315	1115	0315
8	5.0	7.2	-	6.2	4.1	4.3	5.2	5.0	5.9	4.4
9	29	41	43	43	43	32	35	22	35	30
10	270	270	260	260	102	205	155	175	190	212
11	21	37	-	28	38	27	26	29	26	28
12	258	266	-	253	160	202	156	166	185	205
13	-19.0	-12.8	-16.5	-16.5	-22.2	-21.2	-23.0	-20.4	-20.6	-24.6
14	UH	ST	UL	UL	UL	UL	UL	UL	UL	UL
15	4	3	-	2	3	3	-1	2	-1	1
16	40	73	-	54	77	53	62	62	59	57
17	251	204	-	240	158	203	147	166	186	205
18	384	143	-	154	241	-43	-174	144	83	-95

Note: No sounding is available for band no. 73.

TABLE 1. (CONT'D)

Band Number

Row	81	82	83	84	85	86	87	88	89	90
1	3/1/70	3/1/70	3/1/70	3/1/70	3/4/70	11/25/70	11/26/70	11/26/70	11/26/70	11/26/70
2	0030	1220	1545	1915	1300	1550	0015	0135	0600	1430
3	0015	1345	1635	2100	1700	1715	0115	0225	0730	1600
4	S7	S6	NS	S7	S17	S4	NS	S4	S4	NS
5	170	171	172	174	176	179	180	181	182	183
6	SBA	SBA	VLG	SBA	SBA	NTD	SBA	VLG	VLG	SBA
7	0825	1300	1515	2140	1534	?	0030	0315	0315	1422
8	3.7	5.0	4.4	5.7	4.0	7.2	6.4	4.8	4.4	5.4
9	23	22	20	18	52	30	40	38	42	37
10	155	210	225	250	220	260	251	265	230	210
11	20	15	21	15	32	45*	(31)	31	37	37
12	168	192	221	241	200	256*	(253)	263	204	193
13	-27.0	-20.0	-22.8	-20.3	-25.0	-12.0	-13.0	-14.0	-20.0	-17.0
14	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL
15	0	-3	3	-5	5	2	4	0	3	11
16	34	28	43	27	63	49*	57	57	73	71
17	164	191	208	221	193	271*	252	261	200	190
18	9	-8	427	153	-95	495*	257	106	286	-540

Note: Values with astericks were obtained from VEG sounding no. 178, released 1515 PST.

TABLE 1. (CONT'D)

Band Number

Row	91	92	93	94	95	96	97	98	99	100
1	11/29/70	11/29/70	12/2/70	12/2/70	12/10/70	12/13/70	12/10/70	12/13/70	12/20/70	12/21/70
2	0155	0605	0300	0635	0940	1340	1815	2045	2230	0330
3	0445	0810	0535	0700	1100	1805	2035	2200	0115	0440
4	S11	S7	NS	S3	S3	S9	NS	NS	NS	S2
5	187	188	190	192	203	204	206	207	209	210
6	SBA	SBA	SBA	SBA	NTD	VBG	VBG	SBA	SBA	SBA
7	0410	0041	0342	0709	1130	1414	1515	2115	2345	0410
8	6.2	5.6	5.2	4.1	3.8	4.1	4.1	3.7	3.8	3.8
9	54	58	43	49	38	33	35	35	45	34
10	193	202	240	256	199	197	210	210	257	264
11	42	35	(20)	35	21	24	32	32	24	27
12	187	190	(241)	201	170	179	180	195	234	201
13	-20.4	-20.7	-23.0	-23.8	-27.0	-20.7	-20.7	-20.0	-23.5	-20.9
14	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL
15	0	-1	1	4	3	1	2	5	0	1
16	84	64	63	64	44	59	63	67	46	51
17	184	194	244	202	161	188	174	193	227	261
18	-193	-299	-200	-89	-27	694	200	200	-59	-9

TABLE 1. (CONT'D)

Band Number

Row	101	102	103	104	105	106	107
1	12/21/70	12/21/70	2/16/71	2/17/71	3/12/71	4/13/71	4/14/71
2	0530	0740	2145	0105	1945	2320	0225
3	0610	0840	2335	0215	2345	0205	0335
4	S2	NS	S6	NS	S11	S11	NS
5	211	213	218	221	224	226	227
6	VBG	NTD	VBG	NSI	SBA	NTD	VBG
7	0315	0820	2000	0123	2045	0453	0315
8	3.8	3.9	3.3	4.9	4.5	4.4	3.9
9	25	33	22	12	48	22	22
10	260	258	188	200	258	223	223
11	21	27	20	11	39	15	15
12	266	259	188	204	242	209	235
13	-28.1	-27.4	-26.5	-26.1	-15.4	-22.1	-22.1
14	UL	UL	UL	UL	UL	UL	UL
15	0	2	2	2	(9)	4	4
16	41	54	45	19	75	23	27
17	270	262	183	218	237	210	250
18	4	-69	29	-98	-52	-13	-47

TABLE 2. Mean ($\bar{x}$) and Standard Deviation (s) for n Values of each of Twelve Variables from Table 1, Obtained Separately for Nonseeded and Seeded Bands (Rows are numbered with values corresponding to rows in Table 1. See text for further details.)

Row	Variable	Nonseeded Bands			Seeded Bands		
		n	$\bar{x}$	s	n	$\bar{x}$	s
2	Time Difference	51	6.6	3.4	56	5.7	3.7
8	Mixing Ratio	50	5.0	1.1	56	5.1	1.0
9	700-mb Speed	51	35	10	56	35	12
10	Direction	51	234	28	56	227	31
11	Mean Speed	50	26	8	56	28	9
12	Direction	50	224	28	56	218	31
13	500-mb Temp.	51	-20.2	4.5	56	-20.8	4.1
14	Stability Class						
15	Showalter Index	50	4	4	56	3	3
16	Stability Wind	50	50	17	56	54	19
17	Direction	50	221	30	56	215	33
18	Instability Transport	50	72	240	56	116	222

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Concomitant variables, meteorological variables, cloud and atmospheric details.

20. ABSTRACT (continue on reverse side if necessary and identify by block number)

It is recognized that cloud seeding experiments are affected by varying synoptic conditions in the atmosphere. This paper presents and discusses tabulated values of concomitant meteorological variables in Phase I of the Santa Barbara project. These variables include mixing ratio, wind speed and direction, Showalter

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Index, stability wind, and instability transport, all as averages for atmospheric layers. Values of 700-mb wind speed and direction, and 500-mb temperature, as well as specified classes of stability are available from earlier reports on this project and are included in the tabulation.